

Scientifically, however, the most important ichthyological collection exhibited in the Indian department is beyond doubt that shown by Dr. Day—fine specimens in alcohol of several hundred species illustrated in his great work, “The Fishes of India.” Dr. Day also exhibits a set of his coloured drawings of Indian fish.

The Straits Settlements exhibit a fair sample of the sea-fish of that region, unfortunately unnamed; there are also a few fresh water fishes from Singapore.

China has a rich and interesting collection of fish, and also some very good drawings of them. Unfortunately they also are unnamed. The fishes exhibited are principally in alcohol, and come mostly from Swatow; some are very rare, and others appear to be new to science; amongst those of some interest I may mention: *Elacate niger*, *Rhynchobatis ancylostomus*, *Zygæna malleus*, *Cestracion zebra*, and some fine species of *Pteroplatea*, *Trygon*, *Raja*. One fish of special importance is *Polyodon gladius*, from Tchang.

I have now finished, and hope I have been successful in giving a fair general sketch of the Vertebrata shown in the International Fisheries Exhibition; some of the contributions might, no doubt, have been better, but on the whole we may well be content with the opportunity thus given of seeing many good things.

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STELLAR NAVIGATION

Stellar Navigation, with New A, B, and C Tables for Finding Latitude, Longitude, and Azimuth by Easy Methods. By W. H. Rosser. (Published by Norie and Wilson, 1883.)

THERE can be no doubt that star observations, when the horizon is clear and well defined, are the best means by which the position of a ship at sea can be ascertained; as, by altitudes of two or more stars, in suitable positions with regard to the observer, the latitude and longitude can be obtained at the same moment, whereas single observations of heavenly bodies only give one element, and consequently it is not possible to obtain simultaneous observations for both elements during the day, unless either the moon, Venus, or Jupiter passes the meridian whilst the sun is above the horizon.

It is true that when the azimuth of the sun is changing rapidly the latitude as well as the longitude can be obtained from two sets of observations, taken at a given interval of time, provided the alteration in the position of the ship, during that interval, can be accurately determined; but this supposes a knowledge, not only of the course and distance traversed during the interval, but also of the tidal stream or current affecting the ship, which is usually uncertain.

Any writer or teacher, therefore, who impresses on navigators and students the importance of obtaining star observations is deserving of praise, for it is impossible to take too much precaution in ascertaining the position of a ship; cloudy or foggy weather may set in at any moment, and an opportunity lost can never be recovered.

Mr. Rosser has in the *Nautical Magazine* drawn attention to the value of Sumner's method of working out simultaneous observations of two or more stars, and there

is little doubt that it is the best, as it is the only method by which results obtained from simultaneous observations of three or more heavenly bodies can be readily combined. It has been for years constantly used by the naval officers employed on surveying service, and in fact by most navigators, though, perhaps, they seldom take observations of more than two stars at the same time. We however prefer three for precisely the same reason we prefer three to two chronometers.

Sumner's method may be thus briefly described. As at a given moment of time each heavenly body is at the zenith at some point on the earth's surface, so at that moment circles may be described on which its altitude will be 80° , 70° , 60° , &c. If then the altitudes of two stars are obtained at the same instant, and the Greenwich time be known, the two circles of altitude may be drawn on the earth's surface with the points where the stars are in the zenith as centres, and the point where these circles cut will be the position of the observers. In actual practice it is not necessary to draw the circles, it is merely necessary to be able to draw the arc of a small portion of each circle; for the position of the observer being generally known to within twenty miles, the arc of the circle of altitude on which he is situated can be readily drawn.

The method of obtaining this arc of altitude formerly practised was to calculate the longitude with two latitudes, using the same two latitudes for each star, which gave four resulting longitudes; then, by plotting these four longitudes on the two parallels, and drawing lines joining the longitudes given by each star, two circles of altitude were obtained, which either cut in a given point, or would do so when produced, which point was the position of the observer.

This method of calculation was however quickly discarded for a more simple one, where one latitude only was used; for as the azimuth of a heavenly body can be readily calculated at the same time as its hour angle, and the azimuth being the bearing of the place where the star is at the zenith from the observer, it is evident that a line drawn at right angles to the azimuth will be the arc of the circle of altitude on which the observer is situated, as practically the arc is, for so short a distance as twenty or thirty miles, a straight line. The two longitudes on one parallel with the azimuth enable the two arcs of altitude to be plotted as before.

The importance of Sumner's method has not as yet been pointed out in any treatise on navigation, principally because since the time of Lieut. Raper, R.N., no treatise has been written by a practical navigator. It is true the method is mentioned in Riddle's “Navigation,” and was taught by him many years since, though not in the form now adopted, and we think Mr. Rosser has done good service by urging its importance and the importance of stellar navigation generally. All navigators should in our opinion obtain star observations every night and morning, during twilight, as constant practice will alone render them expert in these observations, and familiar with the positions of the stars.

The extra work entailed by such observations will be amply repaid if, when standing in towards the land, after three or four days' thick weather, a partial break in the clouds enables the expert navigator to secure a couple of star observations which give him his position and enable

him to direct his course with confidence towards his point of destination. Whilst, however, giving Mr. Rosser credit for his advocacy, we cannot but regret he has thought it necessary to pad his pamphlet with problems which are in every good treatise on navigation, and with tables which are either useless or are to be found in a more complete form elsewhere.

In "Stellar Navigation," Problems I. to X. are simply repetitions from works already published, and we notice that in the examples given of obtaining hour angle and azimuth (pp. 9, 10, and 11), Mr. Rosser seems to be unaware of the existence of Raper's tables of logarithms of the log. sine square. Problem XI. is an example of Sumner's method, and is well explained, excepting that we think it far better and quite as quick a process to calculate the azimuth with the hour angle rather than refer to another set of tables. Problem XII. is what is called the new navigation, and is merely another, and in our opinion less simple, way of arriving at the same result as Sumner. Problem XIII., or Pagel's method, is merely to obtain the position by calculation instead of by plotting on a chart the two circles of altitude, and as this can be done by two plane triangles we should hardly have thought it required explanation. Problem XIV., to compute the altitude of a heavenly body, will be found in all treatises on navigation.

The Tables A and B are useless, for they are merely a complicated method of finding the error of longitude due to an error of one mile of latitude, which can be readily ascertained by the ordinary traverse-table. Table C., on azimuths, may be, as before stated, as readily and more accurately calculated at the same time as the hour angle. Table D is a combination of two tables invariably given in all treatises on navigation.

Table I., or mean places of stars, is given in the *Nautical Almanac*, which every navigator possesses; Table II. is given more elaborately in Jean's handbook for the stars, which every navigator should possess; and Tables III. and IV. are given in the *Nautical Almanac*.

THE STUDENT'S MECHANICS

The Student's Mechanics. By W. R. Browne. (London: C. Griffin and Co., 1883.)

THIS work, we are told in the Preface, "differs from the many previous works on the subject mainly in the fulness and care with which the foundations" (of mechanics) "have been considered," and it aims at such a treatment of the subject that the student may apply its principles "confidently in attacking questions of practical importance."

The book is characterised by a considerable amount of original and independent thought, especially in the earlier portion treating of First Principles. This is largely due to the definition of matter which is given:—"Matter consists of a collection of centres of force distributed in space, &c." We are not aware of any writer who has employed this hypothesis to deduce and explain the fundamental laws of mechanics in an elementary treatise. Nor does it seem to us at all well adapted to elementary students. It is so very important that they should see that mechanics depends, at every stage, in the establishment of its fundamental laws, on experiment, and also

that they should know what the experiments are and in what way they serve to establish the laws, that the deductive method adopted by Mr. Browne, which does not sufficiently exhibit this connection, would seem to be unsuitable for the purpose he has in view. For though he explicitly states, once or twice, that the science of mechanics rests on experimental evidence, he does not point out the way in which it so rests, nor where the necessity for experiments comes in. As a specimen of his purely deductive method and, at the same time, of poor logic, we have a proof given on p. 9 which reads thus:—"We have defined a force as a cause of motion. Hence we see that, if a force has produced motion, it will be represented to us by the motion it has produced. . . . But motion is measured in terms of velocity. Hence, other things being equal, forces are measured by the velocities which they cause or generate." By the expression "other things being equal" must be understood (Art. 30) that "the things they act upon must be equal" (in what respect—of weight, volume, or mass—is not stated, although, from an illustration previously given, we are, presumably, to infer that their weights must be equal). If we substitute for *force*, *amplitude of vibration*, and for *motion generated*, *intensity of illumination*, all through the above proof, the reasoning will be equally plausible, and the conclusion false. Of course all that can be inferred from the fact of force having caused motion, apart from experiment, would be that the velocity might be expressed as a function of the force.

A possible source of much confusion to the student exists in the old-fashioned division of forces adopted in this book into statical, moving, and accelerating forces. The confusion will be increased by the introduction, in addition, of the more modern word "acceleration." In Art. 348 we have f called the acceleration in the formula $P = Mf$, whilst g is called the accelerating force of gravity; whilst in Art. 422 the actual tractive force P exerted by an engine on the following train is called an accelerating force.

The proof in Art. 359 is incomplete, owing to its not recognising the fact that the sum of an infinite series of vanishing quantities may be a finite quantity.

A valuable feature of the book is the prominence that is given to, and the early introduction of, the theory of the conservation of energy. The friction of machines is deduced from this principle in a very simple manner. The theorems of statics are very clearly put before the reader, and much that is suggestive and valuable is contained in the articles on elasticity and on the action of railway-brakes.

The book is one which may be read with profit by a student who is already familiar with elementary mechanics and is not liable to be confused by the peculiarities alluded to above, but does not seem to be adapted to students who approach the subject for the first time.

OUR BOOK SHELF

Manual of Taxidermy. A Complete Guide in Collecting and Preserving Birds and Mammals. By C. J. Maynard. Illustrated. (Boston: S. E. Cassino and Company, 1883; London: Trübner and Co.)

THIS small volume of 100 pages of thick paper contains the ordinary instructions for skinning, preserving, and